UNIT 2 DATA REPRESENTATION EXERCISES

1. a) Add the following two 8-bit binary numbers

10011011
01010100
11101111

b) An overflow error can occur when adding two adding two 8-bit binary numbers. Describe what is meant by an overflow error. There is an extra bit, as number cannot fit into 8 bits, (The result is greater than 255)

2. The number 73 could be a denary number or a hex number.
a) If 73 is a **hex** number, calculate its value as a **denary** number. Show your working.

Separate the hex digits to find each equivalent in binary. Hex 7=0111 binary, Hex 3=0011,
Piece them together 01110011 Binary
(0x128)+(1x64)+(1x32)+(1x16)+(0x8)+(0x4)+(1x2)+(1x1)=64+32+16+2+1=115 Denary

b) If 73 is a denary number, calculate its value as a hex number. Show working. Answer: 49 Hex
Divide the denary number by 16 to get the number of 16s (the left-hand hex digit). The remainder gives you the units.
73/16=4.56 The left-hand hex digit is 4
The remainder is 0.56 (4.56–4=0.56) 0.56x16=9

3. Numbers can be represented in denary, binary or hexadecimal.
a)(i) Convert the binary number 01101001 to denary, showing your working. Answer 105
(0x128)+(1x64)+(1x32)+(0x16)+(1x8)+(0x4)+(0x2)+(1x1)=64+32+8+1=105

ii) Convert the number 154 to binary:
154 / 2 = 77 remainder **0**
77 / 2 = 38 remainder **1**
38 / 2 = 19 remainder **0**
19 / 2 = 9 remainder **1**
9 / 2 = 4 remainder **1**
4 / 2 = 2 remainder **0**
2 / 2 = 1 remainder **0**
1 / 2 = 0 remainder **1**
Put the remainders together in reverse order 10011010
b) The security code for an alarm system is a long binary number which begins 10001111100101111011...
The technicians prefer to use hexadecimal to enter the security code.

i)When the number is converted into hexadecimal, the first two digits are 8F as shown below
Complete the gaps to show the next three digits
Binary: 1000 1111 1001 0111 1011
Hexadecimal: 8 F 9 7 B

ii) Explain why the technicians prefer to use hexadecimal. Straightforward to convert, shorter number to remember, quicker to enter.
4.a) Explain why data is stored in computers in a binary format.
So that computers can be based on logic circuits. Circuit only needs to check for two states (0 and 1)

b) In the ASCII character set, the character codes for the 1st three capital letters are given below

Letter	ASCII character code
A	0100 0001
B	0100 0010
C	0100 0011

i)State how the ASCII character set is used to represent text in a computer.
Each letter is converted to its character code
ii)Convert the word CAB into binary using the ASCII character set. 0100 0011 0100 0001 0100 0010

iii)Explain why the ASCII character set is not suitable for representing text in all the languages of the world.
ASCII uses 8 bits and can only represent 255/256 distinct characters. Many more characters are needed for coping with all languages (eg Unicode 16bits). ASCII does contain characters used in some languages.

5.When recording a sound file on a computer, the sound needs to be sampled.
a) Describe how sampling is used when storing sound. The height and amplitude of the sound wave is measured at regular intervals and converted to binary

b) Explain the effect of the sampling interval on the size and quality of the sound file recorded.
If you sample more often you have more data to store so larger file but the sound reproduced is closer to the original so better quality.

6. Files are often **compressed** before they are sent over the internet.
a) State what is meant by compression. State one advantage of compressing files before sending them over he internet. Reduce the size of the file. Transmits more quickly.

b) Two types of compression are lossy and lossless.
State which type of compression is most appropriate for each of the following and explain why it is appropriate.
i)Downloading the source code of a large program. Lossless compression. The code has to be exactly as it was originally written or it will not work.
ii)Streaming a large video file. Lossy compression. Faster streaming than lossless.

7.a) The colour depth of an image is defined as the number of bits used to store each pixel. How many bits per pixel are required to store a greyscale image with 256 shades of grey? 8 bits (2^8 = 256 colours)

b) The resolution of an image is the number of pixels that make up an image. Explain the effect of increasing the resolution of an image. Higher resolutions mean that there more pixels per inch (PPI), resulting in more pixel information and creating a high-quality, crisp image

c) A camera takes photographs using a colour depth of 16 bits. It is set to a resolution of 10 megapixels. Calculate the file size in megabytes of a photograph taken using this resolution.
File size =resolution (width x height) x bit depth= 10 MP x 16 bits / 8bits =20MB
To convert bits to bytes you have to divide the count of bits to 8 as one byte contains 8 bits. Divide the number of bytes by 1024 to get the file size in kilobytes. Divide by 1024 again and get the file size in megabytes.

8. When recording sound digitally, two factors influence the quality of the recording: sample rate and sample resolution
a) i) Sample rate is measured in Hertz, where 1 Hert=1 sample per second. Explain what is meant by a sample rate of 30kHz.
This means 30,000 samples per second. The more frequently the sound is sampled, the better the quality of playback
ii) Explain what is meant by a resolution of 16 bits per sample. The number of bits (audio bit depth) used to record each measurement. More bits used per sample enables the height of the wave to be more accurately measured but increases file size

b) A30-second advertising jingle is created using a sample rate of 40kHz and a sample rate of 6 bits. Calculate the size of the sound file. The file size of a sound file=sample rate x sample resolution x seconds. 40 kHz x 1000 (sample rate) x 6 bits x 30 sec / 8 bytes= 900 kB